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Ohno

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[54] **THERMAL-TRANSFER INK RIBBON**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **346/76 PH**; 400/120; 400/241.1; 400/241.2; 156/240; 156/241; 427/146; 428/206; 428/209; 428/346; 428/352; 428/913; 428/904

[58] **Field of Search** ..... 346/76 PH; 400/241.1, 400/241.2, 120; 350/105; 156/240, 241; 428/206, 207, 209, 323, 346, 352, 354, 913, 914; 427/146

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Attorney, Agent, or Firm—Oblon, Fisher, Spivak, McClelland & Maier

[57] **ABSTRACT**

An ink ribbon comprises an ink supporting member, an intermediate layer mounted on the ink supporting member, and ink mounted on the intermediate layer. The ink has supercooling property and is susceptible to softening or melting by heat, and the intermediate layer is adapted to reduce adhesion of the ink to the intermediate layer above a temperature at which the ink is softened or melted. A thermal-transfer recording apparatus best adapted for use of the ink ribbon described above, comprises a thermal head including a plurality of heating elements and being in sliding contact with the ink ribbon, the heating elements being adapted to be heated for predetermined patterns so that the ink of the ink ribbon in sliding contact with the thermal head is heated to be softened or melted into the predetermined patterns, and is transferred to the recording paper overlapping the ink ribbon. The heating elements are located at a downstream end position, with respect to the feed direction of the ink ribbon, on the ink ribbon sliding contact surface of the thermal head.

34 Claims, 5 Drawing Figures

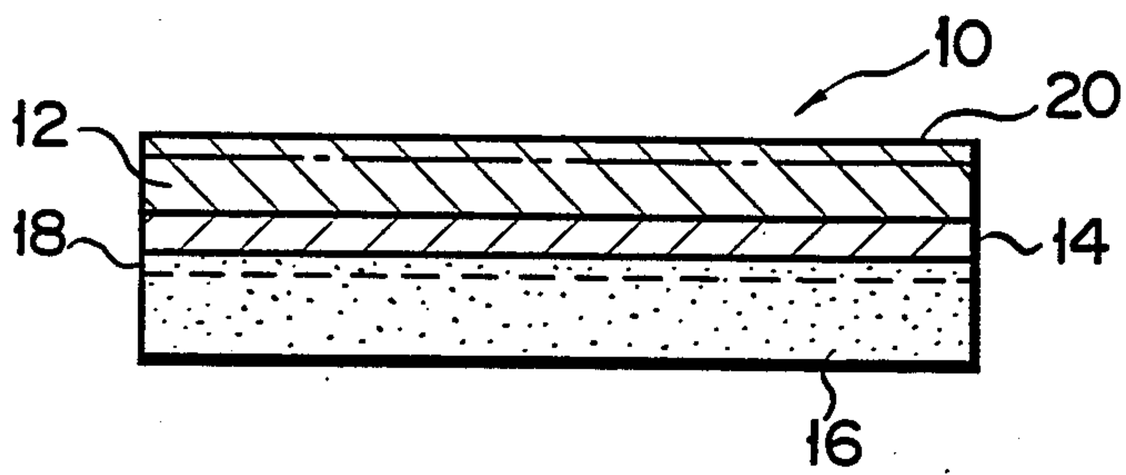


FIG. 1

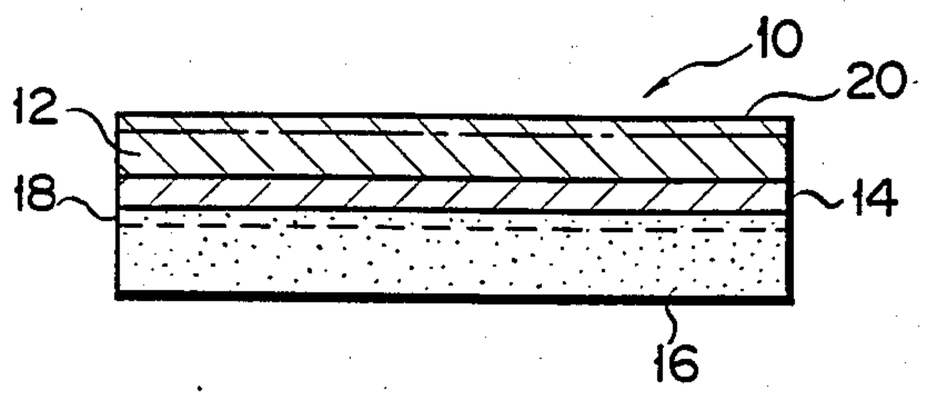

10
20
12
18
14
16

FIG. 2

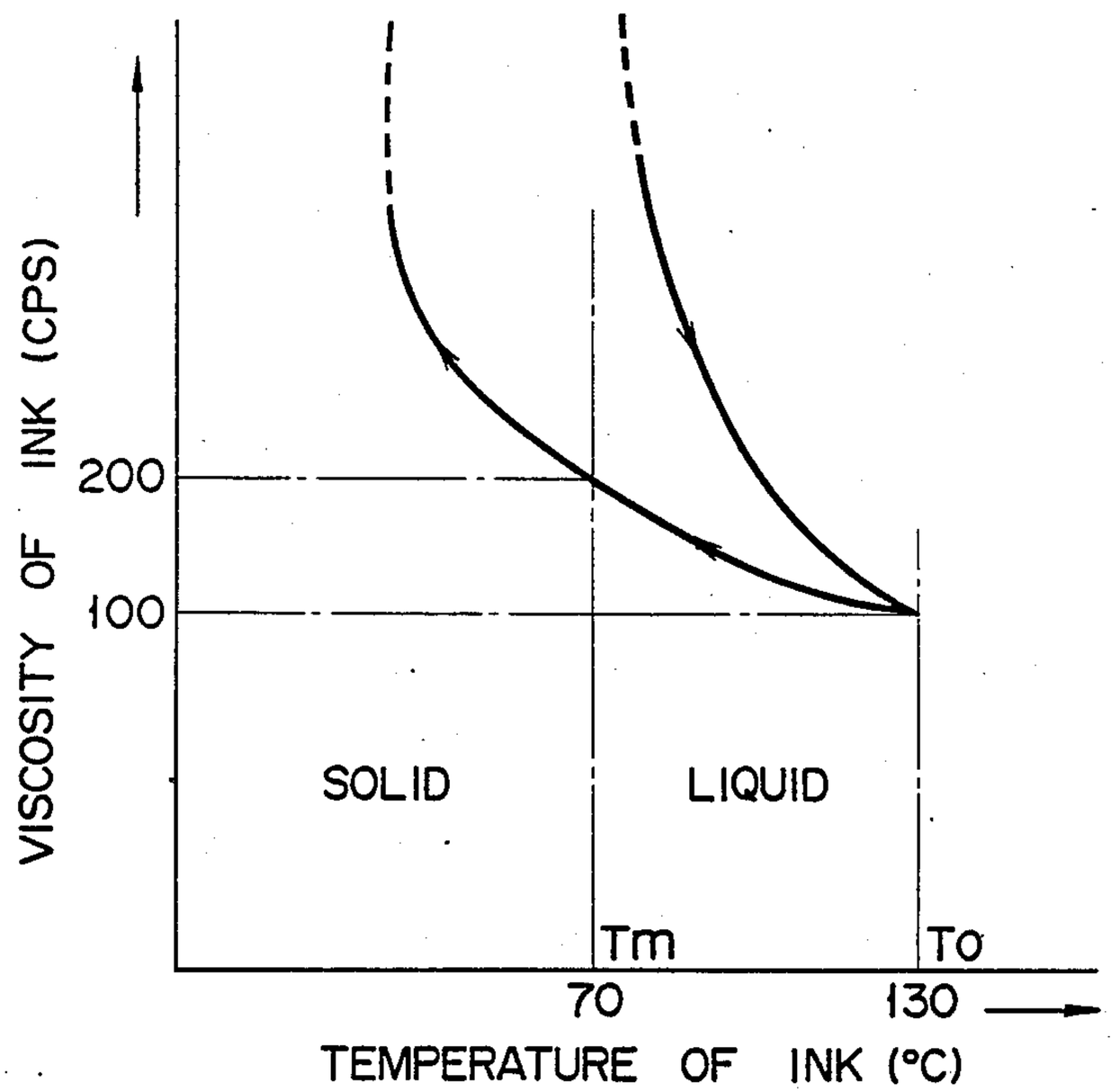

VISCOSITY OF INK (CPS)
200
100
SOLID
LIQUID
Tm
To
70
130
TEMPERATURE OF INK (°C)

FIG. 3

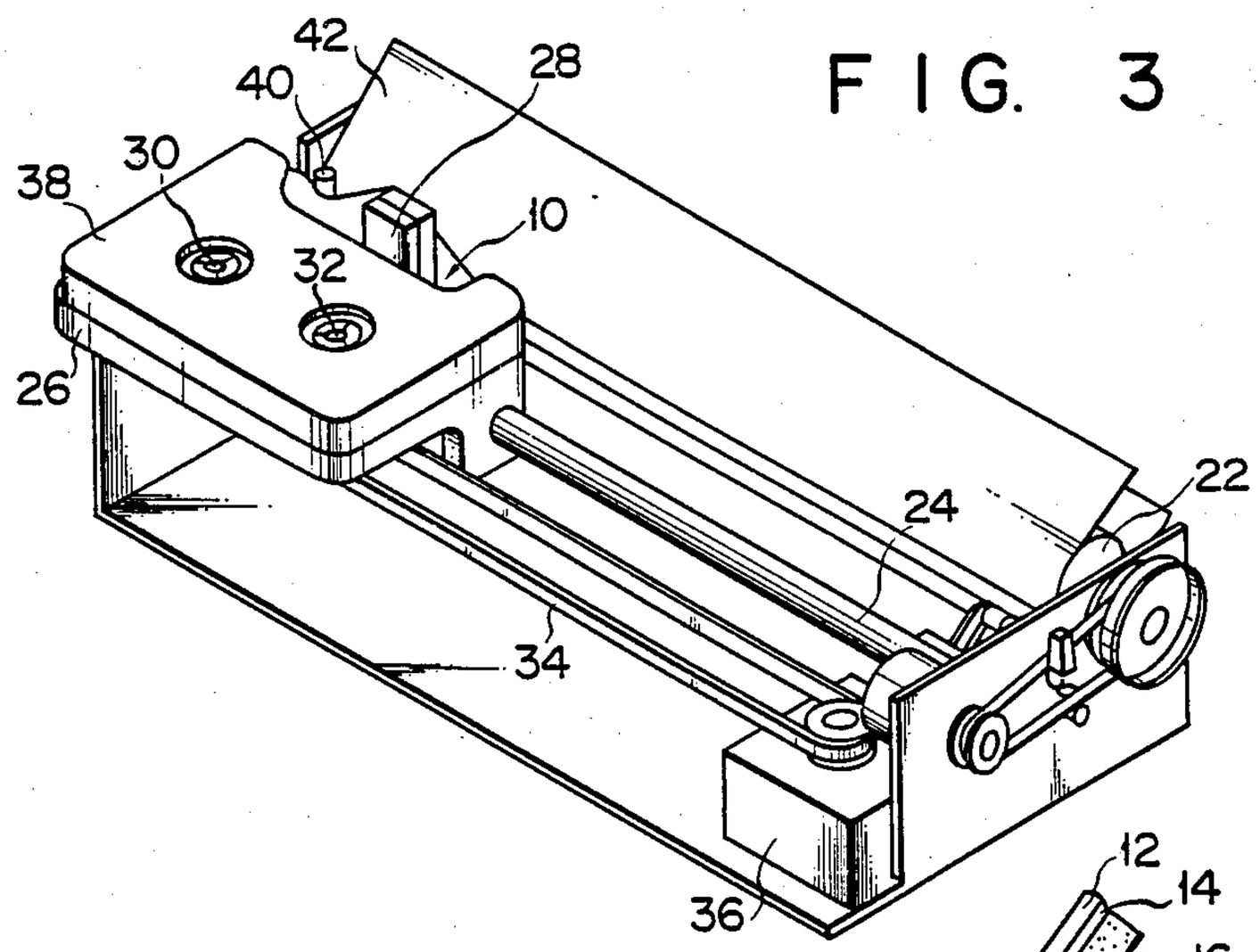


FIG. 4

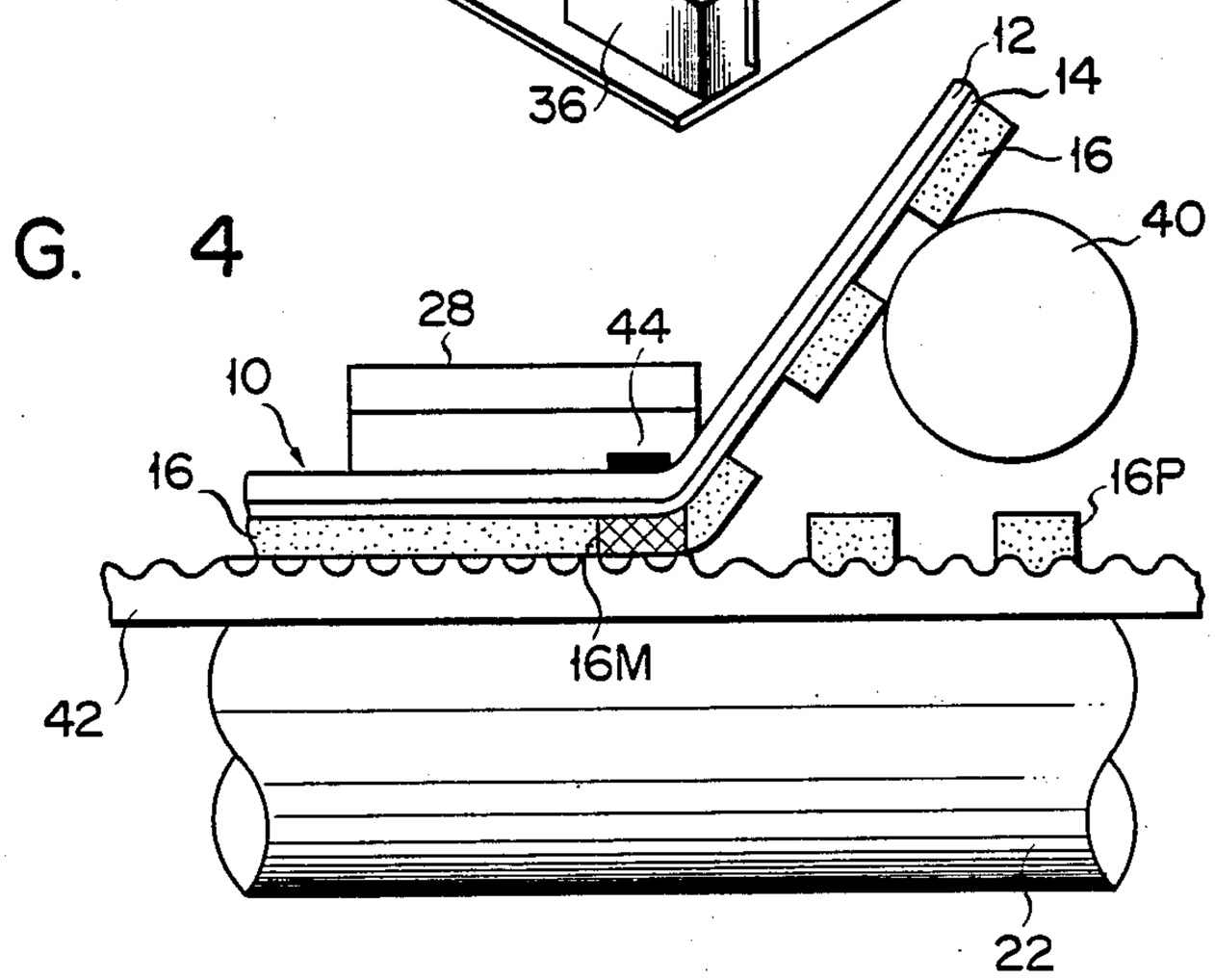
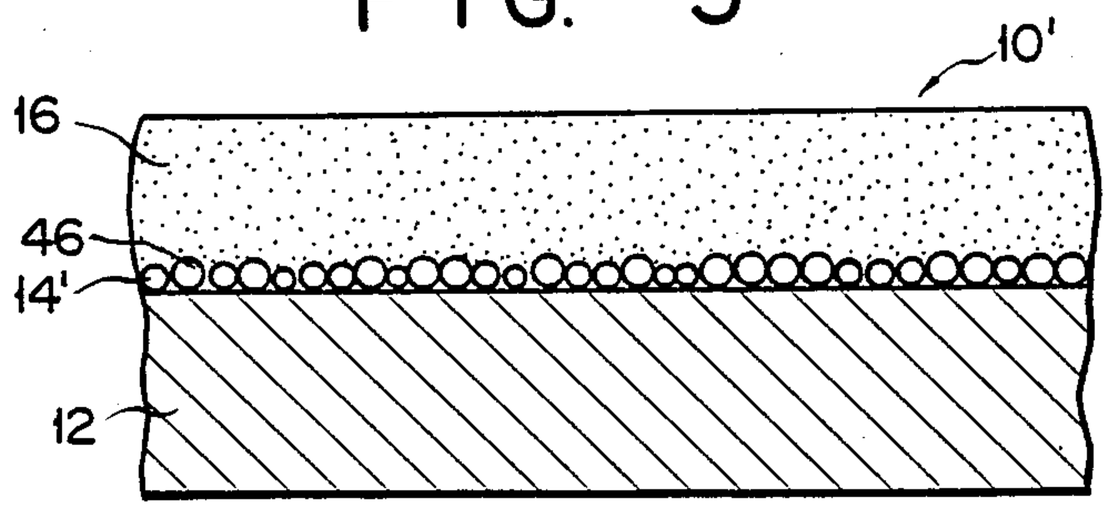


FIG. 5



THERMAL-TRANSFER INK RIBBON

FIELD OF THE INVENTION

The present invention relates to an ink ribbon used by a thermal-transfer recording apparatus and a thermal-transfer recording apparatus best adapted for use therewith.

BACKGROUND OF THE INVENTION

Conventionally, in thermal-transfer recording apparatuses, an ink ribbon overlapping recording paper is heated by a thermal head for desired patterns, such as figures, characters or other signs, so that ink on the ribbon is softened or melted and then transferred to the paper to form the desired patterns thereon. After the transfer, the ribbon is separated from the paper.

The thermal-transfer recording apparatuses using the ink ribbon in which hot melting type ink or hot-softening type ink is mounted on an ink supporting member, and recording desired pattens on a recording paper, can record the desired patterns on the recording paper with a high durability, and are maintenance-free and highly reliable. The recording apparatus of this type have already started to be widely used for both office and personal services, and are still being positively studied and developed in various places.

In the conventional thermal-transfer recording apparatuses, however, ordinary paper, such as PPC paper, bond paper, etc., cannot be used for the recording paper, and special paper with a smoother surface must be used exclusively. If any ordinary paper is used, only a plurality of microscopic projections on the surface of the paper can be in contact with the ink on the ink ribbon. In transferring the ink softened or melted into a desired pattern to be transferred on the surface of the recording paper by means of heating elements on the thermal head constituting the desired patterns, therefore, only those projecting surface portions of the recording paper contacted the ink can catch the ink. Thus, the resulting patterns on the paper are subject to undesired voids or uninked spots.

OBJECTS OF THE INVENTION

The present invention is contrived in consideration of these circumstances, and it is a first object of the invention to provide an ink ribbon capable of satisfactorily transferring ink even to ordinary paper, such as PPC paper, bond paper, etc., without any voids or uninked spots. A second object of the invention is to provide a thermal-transfer recording apparatus best adapted for use with the aforesaid ink ribbon.

SUMMARY OF THE INVENTION

The first object of the invention may be achieved by an ink ribbon which comprises an ink supporting member, an intermediate layer mounted on the ink supporting member, and ink mounted on the intermediate layer, the ink having supercooling property and being susceptible to softening or melting by heat, and the intermediate layer being adapted to reduce adhesion of the ink to the intermediate layer above a temperature at which the ink is softened or melted.

When the ink on the ink ribbon, constructed in this manner, is softened or melted by a plurality of heating elements on a thermal head forming desired patterns to be transferred to the surface of recording paper, adhesion of the ink to the intermediate layer is reduced.

Once softened or melted, the ink, which has supercooling property, remains unsolidified for a predetermined time. Accordingly, even if PPC paper, bond paper or other ordinary paper, of which only the projecting surface portions can be touched by the ink, is used for the recording paper, the ink can very easily be transferred from the intermediate layer of the ink ribbon to the recording paper. Thus, the desired patterns can be inked or recorded on the ordinary paper without voids.

Preferably, in the ink ribbon of the invention described above, the intermediate layer is a metal film. The metal film can be formed on the ink supporting member at low cost by a well-known method.

In the ink ribbon, moreover, the intermediate layer may include capsules distributed substantially uniformly on the ink supporting member and being destroyed when the capsules are heated above a temperature at which the ink is softened or melted, and an adhesion reducing agent stored in the capsules and adapted to reduce the adhesion of the intermediate layer to the softened or melted ink.

In this case, the capsules preferably store a foaming agent being susceptible to foam when the foaming agent is heated above the temperature at which the ink is softened or melted. The foaming agent secures the destruction of the capsules. That is, the transfer of the ink from the intermediate layer to the recording paper above a temperature at which the ink is softened or melted is securely achieved.

Preferably, the ink of the ink ribbon exhibits relatively high cohesion when it is softened or melted by heat. With this property, it can more securely be transferred from the intermediate layer to the recording paper.

The results of various experiments conducted by the inventor hereof indicate that, for secure ink transfer from the ink ribbon to the recording paper, the ink should preferably remain unsolidified for about 50 microseconds or more after the end of heating for softening or melting the ink.

The ink ribbon of the invention may further comprise a solidified ink bonding layer between the intermediate layer and the ink for strengthening the adhesion of the solidified ink to the intermediate layer. The bonding layer securely prevents the solidified ink from separating from the intermediate layer.

Further, the ink supporting member may have a heat resisting layer on the opposite side thereof to the intermediate layer. The heat resisting layer securely prevents the ink supporting member from being damaged or scorched by heat produced by the heating elements of the thermal head.

In the thermal-transfer recording apparatus best adapted for use with the ink ribbon of the invention, the ink of the ribbon remains softened or melted for a longer time after heating than that of the prior art ink ribbon does. Nevertheless, the ribbon can be separated from the recording paper immediately after the ink is heated for transfer, so that the transfer can be finished before the ink, whether softened or melted, is reduced in fluidity that is, while a good transfer condition is maintained.

If the heating elements on the ink ribbon sliding contact surface in the thermal head are located at the downstream end position with respect to the ribbon feed direction, the ribbon and the recording paper can

be separated immediately after the ink of the ribbon is heated for the desired patterns.

Preferably, the recording apparatus further comprises separating means for separating the ink ribbon and the recording paper from each other the moment the ribbon and the paper, facing each other, are separated from the ink ribbon sliding contact surface of the thermal head.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view schematically showing an ink ribbon according to a first embodiment of the present invention;

FIG. **2** is a diagram schematically showing the relationship between temperature and viscosity of ink used in the ink ribbon of FIG. **1**;

FIG. **3** is a perspective view schematically showing the principal part of a serial printer as a thermal-transfer recording apparatus best suited for use with the ink ribbon of FIG. **1**;

FIG. **4** is an enlarged view schematically showing the state in which the ink is transferred from the ink ribbon of FIG. **1** to ordinary paper without special smoothness in the serial printer of FIG. **3**; and

FIG. **5** is a sectional view schematically showing a modified example of a second ink ribbon according to the embodiment of the invention.

Preferred embodiments and modifications of the present invention will now be described in detail with reference to the accompanying drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** shows a cross-section of an ink ribbon **10** according to a first embodiment of the present invention. The ribbon **10** comprises an ink supporting member **12**, an intermediate layer **14** mounted on the ink supporting member **12**, and ink **16** mounted on the intermediate layer **14**.

The ink supporting member **12** may be formed from plastic film, such as polyester, polyethylene, polycarbonate, polyimide, cellophane, etc., or paper such as glassine paper, condenser paper, etc. The intermediate layer **14** may be a metal film of aluminum, nickel or tantalum formed on the ink supporting member **12** by vapor deposition, sputtering or other conventional process of deposition. Alternatively, the intermediate layer **14** may be metallic soap or case in coating the ink supporting member. The ink **16** contains a coloring material, such as carbon black or other pigment or paint, a binder, a supercooling inducing material, and it is applied to the intermediate layer **14**.

The binder used may be natural or synthetic wax e.g., beeswax, carnauba wax, microcrystalline wax, etc. Also, thermoplastic resins, such as vinyl acetate-vinyl chloride copolymer, vinyl acetate-ethylene copolymer, polyamide, etc., may be used for the binder. If binders, which exhibit relatively high cohesion when the ink **16** is softened or melted, the ink **16** exhibits relatively high cohesion when it is softened or melted by heat. As binders described above, thermoplastic resins, such as vinyl acetate-vinyl chloride copolymer vinyl acetate-ethylene copolymer, etc., and mixtures of wax and thermoplastic resin, the mixtures having a melting point of approximately 50° to 200° C. (preferably about 60° to 100° C.) and having a higher proportion of wax than that of the thermoplastic resin may be used. Dicyclohexyl phthalate, benzotriazole, acetanilide, etc., may be used for the supercooling inducing material.

FIG. **2** schematically shows the relationship between the temperature and viscosity of the ink **16** containing the supercooling inducing material according to the first embodiment of the invention. In FIG. **2**, Tm indicates the melting point of the ink **16**, and To designates the maximum temperature to which the ink **16** is heated by a thermal head mentioned later. In this embodiment, the ink **16** is composed of 7 parts by weight of carbon black, 3 parts by weight of oil black, 20 parts by weight of microcrystalline wax, 40 parts by weight of low-molecular ethylene-vinyl acetate copolymer, and 30 parts by weight of dicyclohexyl phthalate.

The fluidity of the ink **16** containing the supercooling inducing material is different at the times temperature of the ink **16** is increasing and its temperature is decreasing. Thus, the fluidity has a hysteretic property. During a temperature rise, the ink **16** suddenly decreases in viscosity and softens or melts when its temperature exceeds the melting point Tm. While the temperature is falling, the supercooling inducing material acts so that the viscosity of ink **16** is much lower than during the temperature rise with the temperature on the same level. Accordingly, the ink **16** can maintain its fluidity despite the temperature below the point Tm. Further, it has a supercooling region of about 20° C.

As shown in FIG. **1**, the ink ribbon **10** of this embodiment further comprises a bonding layer **18** interposed between the intermediate layer **14** and the ink **16**. The bonding layer **18** strengthens the adhesion of solidified ink **16** to the intermediate layer **14**, thereby preventing solidified ink **16** from separating from the intermediate layer **14**. The bonding layer **18** is deposited on the intermediate layer **14** by silane coupling treatment. The bonding layer **18** is destroyed when it is heated by a plurality of heating elements on a thermal head which form desired patterns, such as figures, characters and other signs, to be transferred to the surface of recording paper so as to allow the ink **16**, which is softened or melted into the desired patterns, to come directly into contact with the intermediate layer **14**.

As required, moreover, the ink ribbon **10** of this embodiment may be provided with a heat resisting layer **20** on that surface of the ink supporting member **12** in sliding contact with the thermal head by a well-known method. For example, the heat resisting layer **20** can be made of nitrocellulose or a fluoride.

FIG. **3** schematically shows the principal part of a serial printer, as a thermal-transfer recording apparatus, best adapted for use with the ink ribbon **10** according to the above described embodiment of the present invention. The serial printer is well known and comprises a rotatable cylindrical platen **22**, a guide bar **24** extending parallel to the plate **22**, and a carriage **26** mounted on the guide bar **24** so as to move in the axial direction of the guide bar **24**.

A thermal head **28** having a plurality of resistors constituting the heating elements, a thermal head drive IC (not shown), an ink ribbon take-up reel shaft **30**, and an ink ribbon supply reel shaft **32** are mounted on the carriage **26**. When a printing circuit (not shown) supplies printing signals to the thermal head drive IC (not shown), the IC drives the resistors on the thermal head **28** constituting desired patterns, such as figures, characters and other signs, corresponding to the printing signals to generate heat. The thermal head **28** is movable between a contact position where it is in

contact with the platen **22** and a noncontact position where it is kept apart from the platen **22**. It is driven by a thermal head shifting mechanism (not shown).

The serial printer further comprises a carriage drive motor **36** which delivers a driving force to a carriage **26** through a belt **34**, whereby the carriage **26** is reciprocated. The driving force delivered from the motor **36** to the carriage **26** is transmitted to the ink ribbon take-up reel shaft **30** by means of a gear train (not shown) mounted on the carriage **26**.

The carriage **26** carries thereon ink ribbon cassette **38** which is stored with the ink ribbon **10** according to the first embodiment of this invention. The ink ribbon **10** is wound around an ink ribbon take-up reel and an ink ribbon supply reel which are rotatably held in the cassette **38** and fitted on the reel shafts **30** and **32**, respectively. Between the ink ribbon take-up reel and the ink ribbon supply reel, as shown in FIG. **3**, ink supporting member side surface of the ink ribbon **10** contacts the thermal head **28**, and the ink-side surface of the ink ribbon **10** in the vicinity of the thermal head **28** is in contact with a ribbon-paper separating pin **40** which is fixed to the carriage **26** on the down-stream side of the thermal head **28** (that is, on the side nearer to ink ribbon take-up reel than the thermal head **28**). The moment the ink ribbon **10**, moving from the ink ribbon supply reel to the ink ribbon take-up reel, separates from the sliding contact surface of thermal head **28** bearing the resistors, the pin **40** keeps the ink ribbon **10** away from recoridng paper **42** on the platen **22**.

The printing operation, whether in lateral or vertical lines, of the serial printer with the aforementioned conventional construction is well known. Lateral printing will be described in brief.

In the serial printer described above, when printing signals are delivered from a printing circuit (not shown), the carriage **26** is first moved to a print start position for the initial line, and the thermal head **28** is then shifted to the contact position by a thermal head shifting mechanism (not shown). Thereafter, the moment the resistors on the thermal head **28** constituting the desired patterns, such as figures, characters, and other signs, corresponding to the printing signals are driven for the generation of heat by the thermal head drive IC, the carriage **26** is moved rightward in FIG. **3** at a predetermined speed. At the same time, the ink ribbon **10** is moved from the ink ribbon supply reel to the ink ribbon take-up reel at a predetermined speed. While the carriage **26** is moved rightward in FIG. **3**, the ink of the predetermined patterns responsive to the printing signals delivered successively from the printing circuit is transferred from the ribbon **10** to the recording paper **42**. When the printing of an entire line is finished, the thermal head **28** is shifted to the noncontact position, and the carriage **26** is then moved to a print start position for the next line. At the same time, the platen **22**, along with the paper **42**, rotates for one line in the clockwise direction of FIG. **3**. Thereafter, the aforesaid printing operation processes are repeated. Since the ink ribbon take-up reel shaft **30** is kept from rotating while the carriage **26** is being moved to the print start position for the next line, the ink ribbon **10** cannot be moved from ink ribbon supply reel to ink ribbon take-up reel.

FIG. **4** is an enlarged view schematically showing the state in which the ink **16** is transferred from the ink ribbon **10** to the recording paper **42** in the serial printer described above.

As shown in FIG. **4**, the recording paper **42** is PPC paper or bond paper whose surface is rougher than the specially smoothed surface of conventional exclusive-use paper for thermal-transfer recording. Therefore, only the microscopic projections on the surface of the paper are in contact with the ink **16** of the ink ribbon **10**. A plurality of resistors **44** on the thermal head **28** are located at the downstream end position on the ink ribbon sliding contact surface of the thermal head **28** with respect to the feed direction of the ink ribbon.

Those portions of the bonding layer **18** (see FIG. **1**) corresponding in position to heated resistors **44** are destroyed by high-temperature heat, as mentioned before, so that softened or melted ink **16M** in corresponding positions to heated resistors **44** is brought into contact with the intermediate layer **14**. The ink **16M** contacted intermediate layer **14** is reduced in adhesion to the intermediate layer **14** due to the properties of the intermediate layer **14** described before. Since the ink **16** can be supercooled, softened or melted ink **16M** remains unsolidified for a predetermined time. Further, the cohesion of softened or melted the ink **16M** is relatively high. Therefore, ink **16M** can securely be transferred from the ink ribbon **10** to the recording paper **42**, such as the PPC paper or bond paper, having a relatively rough surface which can contact the ink **16M** on the ink ribbon **10** only at its plurality of projections of the rough surface. Ink **16P** attached on the recording paper **42** forms the desired patterns without any voids or uninked spots.

As mentioned before, the resistors **44** on the thermal head **28** are located at the downstream end position on the ink ribbon sliding contact surface of the thermal head **28** with respect to the ink ribbon feed direction. Also, the moment the ink ribbon **10** separates from the ink ribbon sliding contact surface of the thermal head **28**, the ribbon-paper separating pin **40** makes the ink ribbon **10** move far away from the recording paper **42** on the platen **22**. Further, the ink **16** having a property of supercooling remains softened or melted for a longer time after the finish of heating compared with the prior art ink having no property of supercooling. Thus, the transfering of the ink **16** from the ink ribbon **10** to the recording paper **42** can be finished before the fluidity of the ink **16** is reduced that is, under a good transfer condition.

The results of experiments conducted by the inventors indicate that, for secure the ink transfer from ink ribbon **10** to the recording paper **42**, the ink **16** should preferably remain unsolidified for about 50 microseconds or more after the end of heating for softening or melting of the ink **16**.

Referring now to FIG. **5**, a modified example of the ink ribbon of the invention will be described. In this modification, the same reference numerals are used to designate the same portions as included in the ink ribbon **10** of the foregoing embodiment.

Ink the ribbon **10'** of this modification and ribbon **10** of the above embodiment are different in the construction of the intermediate layer. Intermediate layer **14'** of the ribbon **10'** is formed of a plurality of capsules **46** applied on the ink supporting member **12**, and the ink **16** is applied on the surface of the intermediate layer **14'**.

The capsules **46** are designed so as to be destroyed at a temperature above the temperature at which the ink **16** is softened or melted. The capsules **46** contain an adhesion reducing agent adapted to reduce the adhesion of the intermediate layer **14** to the softened or melted

ink **16**. The capsules **46** can be destroyed by melting the capsule film or by thermally increasing their internal pressure to burst the film. When bursting the film through the pressure increase, the capsules **46** should preferably be loaded with a foaming agent which foams when heated above the temperature at which the ink **16** is softened or melted. The foaming agent makes the bursting of the capsule film easier.

The capsules **46** may be formed by a well-known method, such as interfacial polymerization, coacervation, etc. The shape of each capsule **46** may be any other configuration than the spherical one shown in FIG. **5**. Even though the capsules **46** are sparsely distributed and not in contact with one another, the capsules **46** can give satisfactory transferability to the ink **16** unless they are too scattered. Preferably, however, the capsules **46** should be distributed densely enough to be in contact with one another, as shown in FIG. **5**, for the best transferability.

The thermal-transfer recording apparatus, using the ink ribbon **10** or **10'** according to the two illustrated embodiments of the present invention, has been described as a serial printer herein. Alternatively, however, it may be a line printer, as far as it is constructed so that ink ribbon and recording paper are separated from each other immediately after ink of the ribbon is heated into desired patterns for transfer by a plurality of resistors on the thermal head. It is to be understood, also in this case, that the resistors should preferably be located in the downstream end position at the ink ribbon sliding contact surface of the thermal head with respect to the ribbon feed direction.

What is claimed is:

1. An ink ribbon comprising:
an ink supporting member;
an intermediate layer mounted on the ink supporting member; and
ink mounted on the intermediate layer,
said ink having supercooling property and being susceptible to softening or melting by heat, and
said intermediate layer being adapted to reduce adhesion of the ink to the intermediate layer above a temperature at which the ink is softened or melted.

2. The ink ribbon according to claim **1**, wherein said intermediate layer is a metal film.

3. The ink ribbon according to claim **1**, wherein said intermediate layer includes capsules distributed substantially uniformly on the ink supporting member and being destroyed when the capsules are heated above a temperature at which the ink is softened or melted, and an adhesion reducing agent stored in the capsules and adapted to reduce the adhesion of the intermediate layer to the softened or melted ink.

4. The ink ribbon according to claim **3**, wherein said capsules store a foaming agent being susceptible to foam when the foaming agent is heated above the temperature at which the ink is softened or melted.

5. The ink ribbon according to claim **1**, wherein said ink exhibits relatively high cohesion when the ink is softened or melted by heat.

6. The ink ribbon according to claim **5**, wherein said intermediate layer is a metal film.

7. The ink ribbon according to claim **5**, wherein said intermediate layer includes capsules distributed substantially uniformly on the ink supporting member and being destroyed when the capsules are heated above a temperature at which the ink is softened or melted, and an adhesion reducing agent stored in the capsules and adapted to reduce the adhesion of the intermediate layer to the softened or melted ink.

8. The ink ribbon according to claim **1**, wherein said ink remains unsolidified for about 50 microseconds or more after the end of heating for softening or melting the ink.

9. The ink ribbon according to claim **8**, wherein said ink exhibits relatively high cohesion when the ink is softened or melted by heat.

10. The ink ribbon according to claim **8**, wherein said intermediate layer is a metal film.

11. The ink ribbon according to claim **8**, wherein said intermediate layer includes capsules distributed substantially uniformly on the ink supporting member and being destroyed when the capsules are heated above a temperature at which the ink is softened or melted, and an adhesion reducing agent stored in the capsules and adapted to reduce the adhesion of the ink to the intermediate layer above the temperature at which the ink is softened or melted.

12. The ink ribbon according to claim **1**, further comprising a solidified ink bonding layer between the intermediate layer and the ink for strengthening the adhesion of the solidified ink to the intermediate layer.

13. The ink ribbon according to claim **12**, wherein said intermediate layer is a metal film.

14. The ink ribbon according to claim **12**, wherein said ink exhibits relatively high cohesion when the ink is softened or melted by heat.

15. The ink ribbon according to claim **12**, wherein said ink remains unsolidified for about 50 microseconds or more after the end of heating for softening or melting the ink.

16. The ink ribbon according to claim **1**, wherein said ink supporting member has a heat resisting layer on the opposite side thereof to the intermediate layer.

17. The ink ribbon according to claim **16**, wherein said intermediate layer is a metal film.

18. The ink ribbon according to claim **16**, wherein said ink exhibits relatively high cohesion when the ink is softened or melted by heat.

19. The ink ribbon according to claim **16**, wherein said ink remains unsolidified for about 50 microseconds or more after the end of heating for softening or melting the ink.

20. A thermal-transfer recording apparatus using an ink ribbon which comprises an ink supporting member, an intermediate layer mounted on the ink supporting member, and ink mounted on the intermediate layer, said ink having supercooling property and being susceptible to be softened or melted by heat, and said intermediate layer being adapted to reduce adhesion of the ink to the intermediate layer above the temperature at which the ink is softened or melted, said apparatus comprising:
a thermal head including a plurality of heating elements and slidably contacting the ink ribbon, said heating elements being adapted to be heated for predetermined patterns so that the ink of the ink ribbon being slidably contacted with the thermal head is heated to be softened or melted for the predetermined patterns, and is transferred to the recording paper overlapping the ink ribbon, and
wherein said heating elements are located at a downstream end position, with respect to the feed direction of the ink ribbon, on the ink ribbon sliding contact surface of the thermal head.

21. The thermal-transfer recording apparatus according to claim 20, further comprising separating means for separating the ink ribbon and the recording paper from each other the moment the ribbon and the paper, facing each other, are separated from the ink ribbon sliding contact surface of the thermal head.

22. The thermal-transfer recording apparatus according to claim 20, wherein said intermediate layer of the ink ribbon is a metal film.

23. The thermal-transfer recording apparatus according to claim 20, wherein said ink of the ink ribbon exhibits its relatively high cohesion when the ink is softened or melted by heat.

24. The thermal-transfer recording apparatus according to claim 20, wherein said ink of the ink ribbon remains unsolidified for about 50 microseconds or more after the end of heating for softening or melting ink.

25. The thermal-transfer recording apparatus according to claim 20, further comprising a solidified ink bonding layer between the intermediate layer and the ink for strengthening the adhesion of the solidified ink to the intermediate layer.

26. The thermal-transfer recording apparatus according to claim 20, wherein said ink supporting member of the ink ribbon has a heat resisting layer on the opposite side thereof to the intermediate layer.

27. The thermal-transfer recording apparatus according to claim 20, wherein said intermediate layer of the ink ribbon includes capsules distributed substantially uniformly on the ink supporting member and being destroyed when the capsules are heated above a temperature at which the ink is softened or melted, and an adhesion reducing agent stored in the capsules and adapted to reduce the adhesion of the ink to the intermediate layer above the temperature at which the ink is softened or melted.

28. The thermal-transfer recording apparatus according to claim 27, wherein said capsules store a foaming agent being susceptible to foam when the foaming agent is heated above the temperature at which the ink is softened or melted.

29. An ink ribbon comprising:

(a) an ink supporting member;

(b) ink containing a supercooling inducing material and having a hysteretic property such that, during a temperature rise, it suddenly decreases in viscosity and softens or melts when its temperature exceeds its melting point, but, during a temperature fall, the supercooling material acts so that the viscosity of said ink is much lower at each temperature than it is during the temperature rise;

(c) an intermediate layer mounted on said ink support; and

(d) a bonding layer interposed between said intermediate layer and said ink, said bonding layer being temperature sensitive such that, at a temperature beneath the melting temperature of said ink, it strengthens the adhesion of said ink to said intermediate layer, thereby preventing solidified ink from separating from said intermediate layer, and, at a temperature equal to or above the melting temperature of said ink, said bonding layer is destroyed, permitting said ink to come directly into contact with said intermediate layer.

30. An ink ribbon as recited in claim 29 wherein said bonding layer is deposited on said intermediate layer by silane coupling treatment.

31. An ink ribbon as recited in claim 29 wherein said ink is composed of 7 parts by weight of carbon black, 3 parts by weight of oil black, 20 parts by weight of microcrystalline wax, 40 parts by weight of low-molecular ethylene-vinyl acetate copolymer, and 30 parts by weight of dicyclohexyl phthalate.

32. An ink ribbon as recited in claim 29 wherein said ink comprises a coloring material, a binder, and said supercooling inducing material.

33. An ink ribbon as recited in claim 29 wherein said supercooling inducing material is selected from the group consisting of dicyclohexyl phthalate, benzotriazole, and acetanilide.

34. An ink ribbon as recited in claim 29 wherein said supercooling inducing material is dicyclohexyl phthalate.

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